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CLINICAL RESEARCH

Radiographic Prevalence of Femoroacetabular Impingement in a Young Population with Hip Complaints Is High

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Abstract

Background Femoroacetabular impingement (FAI) is reportedly a prearthritic condition in young adults that can progress to osteoarthritis. However, the prevalence of FAI is unknown in the young, active population presenting with hip complaints.

Questions/purposes We sought to determine (1) the prevalence of radiographic findings of FAI in a young, active patient population with complaints localized to the region of the hip presenting to primary care and orthopaedic clinics; (2) the percentage of films with FAI with an official reading suggesting the diagnosis; and (3) whether the Tönnis grades of osteoarthritis corresponded to the findings of FAI.

Methods We performed a database review of pelvic and hip radiographs obtained from 157 young (mean age 32 years; range, 18–50 years) patients presenting with hip-related complaints to primary care and orthopaedic clinics. Radiographs were analyzed for signs of FAI (herniation pits, pistol grip deformity, center-edge angle, alpha angle, and crossover sign) and Tönnis grade. Radiology reports were reviewed for a diagnosis of FAI.

Results At least one finding of FAI was found in 135 of the 155 patients (87%). Four hundred thirteen of 487 radiographs (85%) had been read as normal and one read as showing FAI. Tönnis grades did not correlate with radiographic signs of FAI.

Conclusions Radiographic evidence of FAI is common in active patients with hip complaints. Increased awareness of FAI in primary care, radiology, and orthopaedic clinics and additional research into the long-term effects of management are warranted.

Level of Evidence Level II, diagnostic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Introduction

FAI is considered by some authors to be a prearthritic condition leading to chondral and labral lesions of the hip, which may progress to degenerative joint disease [6, 11, 12]. Two types of FAI have been described: cam and pincer. In cam-type impingement, the abnormally shaped femoral head-neck junction abuts the anterosuperior acetabulum. In pincer-type impingement, the deep or cranially retroverted acetabulum provides excessive coverage to the

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femoral head and thereby restricts movement [8]. The two types are commonly combined [2].

Numerous plain radiographic findings have been associated with the presence of FAI. These include the pistol grip deformity (decreased femoral head-neck offset), increased α angle, herniation pits, an abnormal center-edge angle, coxa profunda, protrusio acetabuli, and acetabular retroversion [3, 8].

The prevalence of FAI in patients with labral tears seems to be high: in one radiographic review 87% of patients treated for labral tears had at least one abnormal radiographic finding and 35% of patients had more than one finding consistent with FAI [13]. However, this report did not describe the prevalence of FAI among all patients with hip symptoms. Although not confirmed by any long-term study, one report suggested early diagnosis and intervention may improve long-term patient outcomes [6].

We therefore determined (1) the prevalence of radiographic findings of FAI in a young, active patient population with complaints localized to the region of the hip presenting to primary care and orthopaedic clinics; (2) the percentage of films with FAI with an official reading suggesting the diagnosis; and (3) whether the Tönnis grades of osteoarthritis corresponded to the findings of FAI.

Patients and Methods

We identified patients through an electronic database search conducted at William Beaumont Army Medical Center from January 2001 to March 2007. Our presumed military population is representative of a young, active population with daily physical demands. Primary care and orthopaedic clinic patient populations were included. In January 2001, the Department of Radiology transitioned to a completely electronic, retrievable system. We included men and women between the ages of 18 and 50 years with any of a number of International Classification of Diseases, 9th Revision codes of hip complaints (Table 1). We identified 157 patients with 520 radiographs (Fig. 1). The average age of the patients was 32.01 years; 79 of the 157 (50%) patients were male and 78 of 157 (50%) were female. One hundred twenty-four of the 157 patients (79%) had AP films of the pelvis and AP or lateral films of the hip. After assessing quality (see subsequently), 30 AP radiographs of the pelvis were unacceptable: eight were excessively rotated and 22 were excessively tilted. The 30 patients with inadequate AP films of the pelvis were included in the analysis of AP and lateral films of the hip only. Seven patients had only AP films of the pelvis, five of which were adequate for review and two were excessively tilted and excluded. Fifty-six patients had only AP or lateral films of the hip for review (including the 30 patients with inadequate AP films of the pelvis). This left 155 patients with 487 adequate films for analysis (Fig. 1). We had prior Institutional Review Board approval.

We evaluated AP radiographs of the pelvis for pelvic tilt and rotation to determine adequacy for analysis. Pelvic tilt was evaluated by measuring the distance between the sacrococcygeal joint and the pubic symphysis. Our accepted range was 15 to 72 mm for females and 8 to

Table 1. ICD-9 codes associated with hip complaints

Diagnosis	ICD-9 code	Diagnosis	ICD-9 code
Hip, pelvic pain	719.45	Bursitis buttock, trochanter, hip	726.5
Enthesopathy of hip region	726.5	Pelvic pain	625.9
Groin pain	789.0	Buttock pain	729.1
Labral tear hip	718.05	Snapping hip	719.65
Lower extremity pain	729.5	Sacroiliitis	720.2
Acquired deformities of hip	736.3	Synovitis and tenosynovitis	727.0
Femoral acetabular impingement	719.5	Nonspecified derangement of joint	717.9
Juvenile osteochondrosis of pelvis	732.1	Cyst of bone pelvis	733.25
Aseptic necrosis of hip	733.42	Other symptoms referable to joint	719.6
Nonallopathic lesions, not elsewhere classified	739.5	Other bursitis NOS	727.3
Sprain strain hip thigh NOS	843.9	Iliofemoral ligament sprain strain	843.0
Ischiocapsular strain sprain	843.1	Osteoarthritis of pelvis	715.05
Other arthropathies pelvis	716.05	Articular disorder of joint pelvis	718.05
Effusion of joint pelvis	719.05	Loose body in joint pelvis	718.15
Developmental dislocation of pelvis	718.75	Stiffness of joint pelvis	719.55
Sciatica	724.3	Abnormality of gait	781.2

ICD-9 = International Classification of Diseases, 9th Revision; NOS = not otherwise specified.

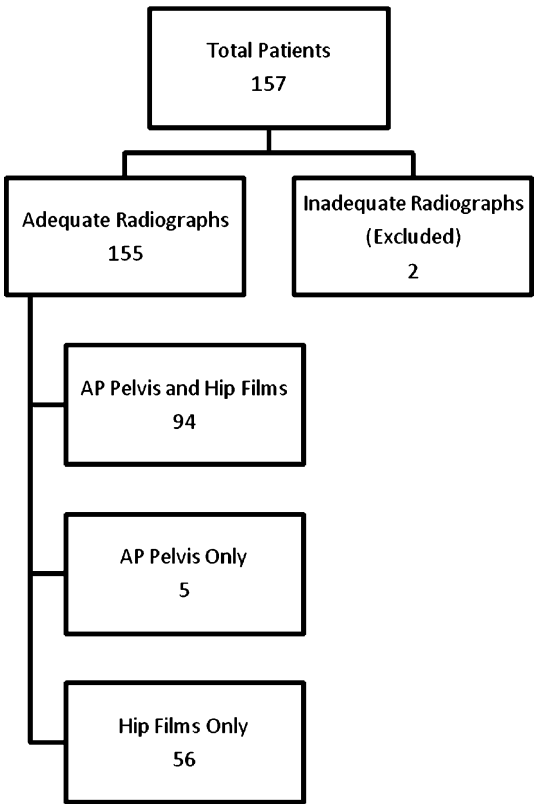

Fig. 1 The diagram shows patient inclusion and exclusion results.

50 mm for males [10]. Rotation was determined by drawing a plumb line from the spinous processes to the pelvis. A distance between the plumb line and the center of the pubis symphysis greater than 16 mm indicated excessive rotation and the radiograph was determined to be inadequate [10]. Any radiographs of the pelvis that were outside these limits were considered inadequate for analysis of the crossover sign and center-edge angle [10].

We recorded the official radiologists' readings in the medical records; interpretations by other clinicians were not included in our analysis. Two of us (LO, LD) independently reviewed all radiographs for (1) herniation pits [1, 3, 8] and (2) pistol grip deformity [11]. The AP films of the pelvis were reviewed for the center-edge angle [8, 12] and crossover sign [1, 3, 8], and the lateral films of the hip were reviewed for alpha angle [1, 3, 8]. AP films of the hip were not used to calculate center-edge angle, crossover sign, or alpha angle. Disagreement between investigators was resolved by the interpretation of the senior author (JH).

The center-edge angle was measured on the AP radiograph of the pelvis by placing the apex of the angle in the center of the femoral head, which was determined using circular templates on a manual goniometer. Once the center of the femoral head was determined, the electronic tool for angular measurement was used on each radiograph. The angle was formed from the straight vertical to the edge of the acetabular ceiling. A center-edge angle less than 20 was considered dysplastic, an angle from 21 to 38 was considered normal, an angle from 39 to 44 was considered coxa profunda, and an angle greater than 44 was considered protrusio acetabuli [12].

We measured the alpha angle on the frog-leg lateral radiograph of the hip. The apex was placed in the center of the femoral head as determined with circular templates on a manual goniometer. The angle was made by the axis of the femoral neck and the point at which the femoral head radius of curvature exceeded a round shape as described by Nötzli et al. on MRI of the hip [9]. The reliability of this measurement on frog-leg lateral films of the hip subsequently was confirmed by Clohisy et al. [5]. Angles that exceeded 50° were considered abnormal [1].

We graded all radiographs for osteoarthritis using the Tönnis grading system [12]. Tönnis grades were compared between patients with signs of FAI and those without.

Results

At least one radiographic finding of FAI was present in 135 of the 155 patients (87%) Of the 94 patients with adequate AP films of the pelvis and hip allowing full radiographic review of all signs of FAI, 88 patients (94%) had at least one radiographic finding consistent with FAI and 81% had at least two findings. Fifty-seven patients (65%) with full radiographic review had combined impingement as observed by abnormal alpha angles or pistol grip deformity combined with abnormal center-edge angles and/or crossover signs. Fifteen patients (17%) with full radiographic review had signs of pure cam impingement (abnormal alpha angle or pistol grip deformity only), whereas 16 patients (18%) had signs of pure pincer-type impingement (abnormal center-edge or crossover sign only).

None of the 439 radiographs that showed FAI on our review had a radiologist's reading suggesting FAI. Four hundred thirteen of the 487 radiographs (85%) were read as entirely normal and only one of the radiographs was read as showing FAI; one radiograph read by the radiologist as showing FAI had no radiographic findings consistent with FAI by our review.

The Tönnis grade was 0 in 93 of the 155 patients (61%), 1 in 44 patients (28%), 2 in 10 patients (6%), and 3 in five patients (3%). Among the 135 patients with FAI, 39 (29%) had Grade 1, eight (6%) had Grade 2, and five (2%) had Grade 3.

Discussion

Femoroacetabular impingement is considered by some authors to be a prearthritic condition [6, 11, 12]. The general prevalence of FAI is estimated at 10% to 15% in asymptomatic patients [7]. Although unconfirmed by any long-term studies, one report suggested early diagnosis and intervention may halt the progression to hip arthrosis [6]. We sought to determine (1) the prevalence of radiographic findings of FAI in a young, active patient population with complaints localized to the region of the hip presenting to primary care and orthopaedic clinics; (2) the percentage of films showing FAI with an official reading suggesting the diagnosis; and (3) whether the Tönnis grades of osteoarthritis corresponded to the findings of FAI.

We acknowledge several limitations of our study. First, it is a database review and was limited by the number of patients with adequate radiographs. The 87% prevalence of FAI is a conservative estimate, because this percentage was based on patients who had only AP films of the pelvis or hip along with those having full radiographic review. When we determined the prevalence among patients with AP films of the pelvis and hip, the prevalence of FAI increased to 94%. Second is the ill-defined parameters for measuring the center-edge angle on the AP radiograph of the pelvis when the patient has acetabular crossover and acetabular osteophytes. We measured to the edge of the rim of the superior acetabulum (sourcil) and did not include the overhang from the anterior wall of the acetabulum. The true overcoverage of the femoral head includes the overhang of the anterior wall of the acetabulum, but this has not been completely defined in the description of the center-edge angle. Thus, we may have underestimated the number of patients with anterior acetabular overcoverage. Third, the intraobserver and interobserver reliabilities of the radiographic evaluation of the hip have come into question. A recent study showed the intraobserver and interobserver reliabilities of acetabular version, head-neck offset, pelvic tilt, and pelvic rotation to be poor (kappa < 0.6) with the intraobserver reliability of Tönnis grades achieving a kappa value of 0.6 [4]. Fourth, our study does not include clinical data such as presence of the impingement sign (pain on deep hip flexion with adduction and internal rotation) on physical examination, analysis of the interpretation of radiographs by primary care and orthopaedic providers, or assessment of functional limitations associated with the patients' hip complaints. This was a purely retrospective study during a time when FAI was not treated at our institution. Fifth, the final diagnoses assigned to the patients were not considered in our analysis, specifically diagnoses such as sacroiliitis or sciatica, in which clinical symptoms may not be directly referable to the hip. We chose to include all patients with complaints involving the general region of the hip to analyze a larger patient population. Inclusion of these patients may have caused us to underestimate the prevalence of signs of FAI in our patient population. Finally, we did not differentiate patients with diagnoses of aseptic necrosis of the hip or developmental hip dysplasia. On our review, we did not measure any center-edge angles that would be consistent with developmental dysplasia nor did we appreciate radiographic signs of aseptic necrosis. We also excluded all patients older than 50 years with the hopes of separating patients with primary osteoarthritis from our data pool. If these diagnoses were indeed present in our patient population, they may have falsely elevated the Tönnis grades of these patients independent of radiographic signs of FAI.

Sixty-five percent of the patients examined with full radiographic review had abnormal alpha angles or pistol grip deformity combined with abnormal center-edge angles and/or the presence of a crossover sign, implying the presence of cam and pincer impingement mechanisms. This is consistent with previously published findings that impingement often is combined [2]. One radiographic review of patients treated for labral tears found 87% of patients had at least one abnormal radiographic finding consistent with FAI [13]. This mirrors our result of 87% of all patients with hip complaints having at least one radiographic finding consistent with FAI. In patients with full radiographic review, our data suggest a radiographic prevalence of FAI of 94% with 81% having more than one finding consistent with FAI.

During the period studied, FAI was not well recognized or commonly treated at our institution. It is not surprising that review of official radiology reports of all films analyzed in this study showed that 85% of films showing signs of FAI were read as normal. None of the films showing findings of FAI had an official report suggesting the diagnosis of FAI, and the one film that was read as showing FAI did not have any findings consistent with FAI. We cannot comment on the interpretations of the radiographs by nonradiology providers, because this information was not included in our data set.

FAI is considered by some authors to be a prearthritic condition of the hip [6, 11, 12]. We found the distribution of Tönnis grades was the same regardless of the presence of radiographic signs of FAI. In the limitations of our study, we cannot comment of the length of time that these patients were symptomatic and can provide no insight regarding whether patients with more prolonged symptoms had higher Tönnis grades than those with symptoms of more recent onset.

All of the patients in this study had presented to primary care or orthopaedic clinics with hip complaints. Our data suggest the radiographic prevalence of FAI is high in young, active patients who present with

complaints localized to the region of the hip. Because the presence of FAI has been associated with chondral and labral lesions of the hip and progression to osteoarthritis, it is important to recognize patients with these radiographic findings early. Increased awareness in primary care, radiology, and orthopaedic clinics of radiographic findings consistent with FAI may assist with earlier diagnosis. Given the morbidity of early degenerative disease of the hip, long-term data regarding the effects of early diagnosis and surgical intervention are needed.

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